# Conceptual CCR Closure Cost Estimates Summary Report

## Duke Energy Carolinas, LLC

**Duke CCR Closures**
**Project No. 148459**

**12/11/2023**

# Conceptual CCR Closure Cost Estimates Summary Report

**prepared for**

**Duke Energy Carolinas, LLC**
**Duke CCR Closures**
**Charlotte, North Carolina**

**Project No. 148459**

**12/11/2023**

**prepared by**

**Burns & McDonnell Engineering Company, Inc.**
**Kansas City, Missouri**

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# LIST OF ABBREVIATIONS

| Abbreviation | Term/Phrase/Name |
|---|---|
| AACE | Association for the Advancement of Cost Engineering |
| Burns & McDonnell | Burns & McDonnell Engineering Company, Inc. |
| CbR | Closure by Removal |
| CCR | Coal Combustion Residual |
| CCR Rule | *40 CFR Parts 257 and 261 Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register, v.80, no. 74, April 17, 2015,* and subsequent amendments |
| C.F.R. | Code of Federal Regulations |
| CiP | Closure in Place |
| DSM Wall | Deep Soil Mixed Wall |
| Duke | Duke Energy Carolinas, LLC |
| EREF | Environmental Research & Education Foundation |
| IAB | Inactive Ash Basin |
| LCID | Land Clearing and Inert Debris |
| LF | Linear feet |
| MSW | Municipal Solid Waste |
| Troutman | Troutman Pepper Hamilton Sanders LLP |
| QA/QC | Quality Assurance/Quality Control |

# 1.0 EXECUTIVE SUMMARY

At the request of Troutman Pepper Hamilton Sanders LLP (Troutman) on behalf of Duke Energy Carolinas, LLC (Duke), Burns & McDonnell provided engineering services regarding coal combustion residual (CCR) unit closure costs. Burns & McDonnell prepared AACE Class 5 level (https://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf) closure cost estimates for CCR units located at Duke's North Carolina Plants, which include Allen, Belews Creek, Buck, Cliffside (Rogers Energy Complex), Dan River, and Marshall. Consistent with the defined AACE Class 5 level cost estimate approach, the resulting conceptual screening cost estimates were based on information for each impoundment either provided by Duke or available publicly via the internet. Duke prescribed which closure approach (or approaches) and corresponding cost estimates were to be prepared at each of the sites, being either Closure in Place (CiP) or Closure by Removal (CbR) with offsite disposal, and the resulting cost estimates are defined in Table 1-1.

**Table 1-1: Pond Closure Estimate Summary**

| Site | Unit | Cost to Close in Place | Cost to Close by Removal |
|---|---|---|---|
| Allen | Retired Ash Basin | $281,952,800 | N/A |
| | Active Ash Basin | $559,738,000 | N/A |
| Belews Creek | Active Ash Basin | $947,741,900 | N/A |
| Buck | Ash Basin 1 | $245,790,400 | $423,258,900 |
| | Ash Basin 2 & 3 | $224,968,600 | $387,327,300 |
| Cliffside (Rogers Energy Complex) | Unit 5 Inactive Ash Basin | $103,370,600 | N/A |
| | Active Ash Basin + Ash Storage 1 | $381,808,000 | N/A |
| Dan River | Primary & Secondary Ash Basin | $136,918,100 | N/A |
| | Ash Stack 1 | $72,589,300 | N/A |
| | Ash Stack 2 | $9,621,100 | N/A |
| Marshall | Active Ash Basin | $1,198,744,300 | N/A |

This Report provides a more detailed summary of the items considered in building up the costs presented above, including a brief description of guiding assumptions, quantities, unit rates, and total costs.

# 2.0 SCOPE OVERVIEW

At the request of Troutman Pepper Hamilton Sanders LLP (Troutman) on behalf of Duke Energy Carolinas, LLC (Duke), Burns & McDonnell, under the direction of Mr. Mark Rokoff, P.E., provided engineering services regarding CCR unit closure costs. More specifically, Burns & McDonnell prepared AACE Class 5 level (https://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf) closure cost estimates for CCR units located at Allen, Belews Creek, Buck, Cliffside (Rogers Energy Complex), Dan River, and Marshall Plants based on information for each impoundment provided by Duke and a conceptual evaluation of the scope required to complete the work. No engineering design work was performed, only development of quantities for the purposes of cost estimating. At each of the sites, Duke prescribed which closure approach (CiP and/or CbR) and corresponding cost estimate was to be prepared as summarized in Table 2-1.

**Table 2-1: Summary of Scope Evaluated**

| Site | Unit | Closure Approach | |
|---|---|---|---|
| | | CiP | CbR |
| Allen | Retired Ash Basin | Yes | N/A |
| | Active Ash Basin | Yes | N/A |
| Belews Creek | Active Ash Basin | Yes | N/A |
| Buck | Ash Basin 1 | Yes | Yes |
| | Ash Basin 2 & 3 | Yes | Yes |
| Cliffside (Rogers Energy Complex) | Unit 5 Inactive Ash Basin | Yes | N/A |
| | Active Ash Basin + Ash Storage 1 | Yes | N/A |
| Dan River | Primary & Secondary Ash Basin | Yes | N/A |
| | Ash Stack 1 | Yes | N/A |
| | Ash Stack 2 | Yes | N/A |
| Marshall | Active Ash Basin | Yes | N/A |

# 3.0 ESTIMATE DEVELOPMENT APPROACH

## 3.1 General Approach

Burns & McDonnell has developed AACE Class 5 level closure cost estimates for CCR units located at the following Duke North Carolina sites: Allen, Belews Creek, Buck, Cliffside (Rogers Energy Complex), Dan River, and Marshall Plants. The following discussion describes the general approach used to establish the costs for CiP and CbR (Section 3.1.1 and 3.1.2, respectively) as well as the methodology employed for development of the unit rates (Section 3.2) and corresponding quantities (Section 3.3).

### 3.1.1 Closure in Place (CiP)

Closure in place describes an approach to meet the requirements of the CCR Rule for closure of the site with the CCR materials remaining in place. The key closure components evaluated in building up the overall cost estimate are described in the following subsections, along with relevant information regarding Burns & McDonnell's general approach and assumptions.

#### 3.1.1.1 Mobilization/Demobilization & Site Preparation

For each of the CCR units assessed, costs were allocated to account for mobilization/demobilization of standard earthwork equipment, establishment of minor site facilities, and implementing appropriate security and safety measures. This line item also includes necessary erosion controls within the pond footprint to limit erosion prior to completion of final cover installation and establishment of vegetation, and, where necessary, the removal of mature trees and vegetation.

##### 3.1.1.1.1 Flood Mitigation

40 C.F.R 257.52 references Part 257.3-1 (floodplains) which states, "Facilities or practices in floodplains shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources." Pursuant to this requirement, improvements to the CCR units were included in areas where flooding within the footprint of the CCR unit and/or adjacent to the CCR unit was of concern.

In general, where the 100-year flood elevations coincide with the dikes of the CCR units, the CiP approach included armoring of the exterior slope of the dikes to an elevation 5 ft. or greater than the flood level to account for potential wave action along the length of the CCR units within the floodplain. Note that the selection of the closure approach should carefully consider the impacts of flood events, and this may lead to additional controls or measures or ultimately the selection of the CbR approach.

### 3.1.1.2 Dewatering

For each CCR unit, an assessment was made regarding the presence of water within the upper portion of the CCR materials and ultimately the approach to removing this water to support the construction of the cover system and maintain long term performance of the cap components. The assessment assigned a qualitative degree of saturation (low, moderate, or high) within the upper 10 feet of the CCR unit using data provided by Duke. Based upon the saturation designation, dewatering activities were estimated with a corresponding level of effort of various standard dewatering methods. Dewatering activities considered for each site included solutions such as:

- Geogrid to stabilize an area and/or provide access;
- Stockpiling CCR materials through traditional excavation and allowing the material to decant over a limited time period;
- Drainage trenches, narrow in width, excavated to limited depths and allowed to remain open to redirect incoming flows. As appropriate, small pumps would be incorporated to actively dewater the surrounding CCR material; and
- Cement stabilization, which involves the introduction of a small percentage of cement mixed into the CCR materials resulting in a stabilized CCR-cement matrix.

It is recognized that the actual method(s) for dewatering are very site specific and dependent upon in-situ characteristics of the CCR; however, implementing this general approach is intended to be consistent with the level of effort associated with an AACE Class 5 level estimate.

### 3.1.1.3 Engineering Controls

As indicated in its responses to the Part A determination for other sites issued on January 11, 2022, EPA interprets the CCR Rule to require that when CCR materials are in contact with groundwater and closure in place is the intended closure method, the performance standard requires appropriate measures, such as engineering controls, to control, minimize, or eliminate infiltration through the unit. For this reason, each CCR unit was assessed based on available data to determine the potential presence of groundwater within the CCR materials and, where present, costs were included for an engineered control to constrain the flow of water across the CCR unit boundary.

The engineering control systems incorporated to satisfy the performance standard considered two variations of a hydraulic cut-off system. First, where an existing, low permeability soil unit was present below the aquifer and appeared to be sufficient to serve as a hydraulic barrier, a non-structural slurry wall was incorporated into the overall CCR unit cost estimate. Second, where a notable soil unit under the CCR unit capable of providing a hydraulic separation was not present, an in-situ stabilization (ISS) solution was incorporated as the engineered control. In this application, a targeted ISS approach was developed assuming a 5-foot-thick zone of ISS underlying the footprint of the CCR unit and full-depth ISS around the unit perimeter (across a width of three feet) to fully enclose the ponded CCR materials. Note that the remaining separable pore water present after the installation of engineering controls will be removed via the system discussed in Section 3.1.1.4.

#### 3.1.1.4 Pore Water Removal

As indicated in its responses to the Part A determination for other sites issued on January 11, 2022, EPA interprets the CCR Rule to require that free or separable pore water within the CCR unit is to be removed as part of the unit closure. Therefore, CCR units were reviewed to identify the presence of groundwater within the unit considering the potential influence on the presence of separable pore water.

While the specific site conditions (i.e., the in-situ properties of the CCR/pond materials and the presence of separable pore water) are not defined, for the purpose of an AACE Class 5 level estimate it was assumed that well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present and supported by appropriate extraction infrastructure would be sufficient for removal. It is assumed that the well point system is shut down after one year due to diminishing returns.

Note that this line item addresses the removal of separable pore water that may be present within the CCR unit following the implementation of the engineering controls which are discussed in Section 3.1.1.3.

#### 3.1.1.5 Water Treatment

To support closure construction, bulk water (i.e., free water, water collected during dewatering activities, and water extracted via the pore water removal system) present at the CCR unit may need to be treated prior to discharge. For the cost estimate, Duke provided a representative unit cost for water treatment based on actual costs from similar treatment at CCR pond closure sites within the Carolina sites. The unit cost was based on a volume of CCR material treated, which for CiP was assumed to be a 10-foot depth over the footprint of the CCR unit.

#### 3.1.1.6 Stabilization

A review of available information prepared by others did not indicate the presence of an unstable static, seismic, and/or liquefaction condition (based on the required analyses presented in 40 C.F.R 257.73) which would require stabilization if the CCR unit is to close in place. Therefore, costs were not included for site-specific stabilization to support the AACE Class 5 level estimate (it has been noted that formal investigation and design has not been conducted as part of this study).

#### 3.1.1.7 Subgrade Preparation

Prior to installing the final cover system, the CCR unit must be shaped and compacted to provide a stable and well-draining surface. For this scope, a cost was determined by assuming a generalized thickness for cut and fill grading across the unit footprint (consistent with an AACE Class 5 level estimate, design of the site contours in the closed configuration was not performed).

#### 3.1.1.8 Cover System

The proposed cover system was selected to meet the requirements of CCR Rule. For each CCR unit, the final cover system consisted of (1) a geomembrane liner, (2) a geocomposite, (3) 12-inches of protective cover (soil), and (4) 6-inches of topsoil. Consistent with the requirements of the CCR Rule, the geomembrane liner will serve as the infiltration layer. Each existing CCR unit is assumed to be unlined; however, the permeability of existing subsoils present is unknown. It can be assumed that the geomembrane will have a permeability less than or equal to the existing subsoils (consistent with an AACE Class 5 level estimate, no subsurface investigation was performed). The presence of a geocomposite will facilitate drainage over the geomembrane and help prevent erosion of the overlying soil layers. The 12" protective cover will provide a protection layer for the underlying geosynthetics and the 6" topsoil will be seeded and serve as the erosion layer.

Soil needed to construct the cover system will be obtained from an offsite borrow source. For the AACE Class 5 level estimate, it was assumed that borrow material in adequate quantity and quality will be available within 5-miles of the project site and is suitable for use without additional processing. Borrow quantities include 10% extra material to account for shrinkage and waste. Costs are also included for managing erosion and restoring the borrow site.

#### 3.1.1.9 Stormwater and Erosion Controls

Management of stormwater and erosion following the installation of the final cover system is required in the CCR Rule. Each CiP estimate includes development of a dedicated stormwater detention pond to control runoff over the cover system. The stormwater pond capacity was based on a the 10-year, 24-hour design runoff volume over the cover system footprint assuming runoff will overflow to a perimeter ditch and be conveyed to a new stormwater pond sited approximately 200 feet outside the limits of the CCR unit. Each stormwater pond estimate includes an outlet structure and emergency spillway; however, the exact location and size would be determined in subsequent design efforts.

#### 3.1.1.10 Engineering, Permitting, QA/QC, Owner's Costs and Contingency

Estimates for engineering, permitting, Quality Assurance/Quality Control (QA/QC), owner's costs and contingency were incorporated based on various percentages of the total costs and/or engineering judgement. QA/QC costs were estimated based on a common per acre rate consistent with the type of services anticipated in the CiP approach. Engineering, permitting, and owner's costs were estimated as 10% of the subtotal for construction costs and QA/QC (without contingency). Similarly, contingency was estimated as 30% of the subtotal of construction costs and QA/QC, consistent with an AACE Class 5 level estimate.

### 3.1.2 Closure by Removal (CbR)

Closure by removal describes an approach to meet the requirements of the CCR Rule for closure of the site by removing all of the CCR materials and placing them in an appropriate disposal site (or beneficial use if applicable, but not anticipated for the costs presented herein). For each of the key closure components which combine to represent the overall cost estimate, the following subsections provide a description and relevant information regarding Burns & McDonnell's general approach and assumptions.

#### 3.1.2.1 Mobilization/Demobilization & Site Preparation

*(Same approach as described in Section 3.1.1.1).* For each of the CCR units assessed, costs were allocated to account for mobilization/demobilization of standard earthwork equipment, establishment of minor site facilities, and implementing appropriate security and safety measures. This line item also includes necessary erosion controls within the pond footprint to limit erosion prior to completion of final cover installation and establishment of vegetation, and, where necessary, the removal of mature trees and vegetation.

#### 3.1.2.2 Dewatering

*(Similar general approach as described in Section 3.1.1.2).* Within each CCR unit, an assessment was made regarding the presence of water throughout the CCR materials and ultimately the approach to removing this water to support the excavation and certification of the CCR removal. For each unit, the assessment assigned a qualitative degree of saturation (low, moderate, or high) for the CCR unit. Based upon the saturation designation, dewatering activities were estimated with a corresponding level of effort of various standard dewatering methods. Dewatering activities considered for each site included solutions such as:

- Geogrid to stabilize an area and/or provide access;

- Stockpiling CCR materials through traditional excavation and allowing the material to decant over a limited time period;
- Drainage trenches, narrow in width, excavated to limited depths and allowed to remain open to redirect incoming flows. As appropriate, small pumps would be incorporated to actively dewater the surrounding CCR material. Additionally, as the CCR materials are removed, drainage trenches may be deepened or added to the CCR unit; and
- Cement stabilization, which involves the introduction of a small percentage of cement mixed into the CCR materials resulting in a stabilized CCR-cement matrix.

It is recognized that the actual method(s) for dewatering are very site specific and dependent upon in-situ characteristics of the CCR; however, implementing this general approach is intended to be consistent with the level of effort associated with an AACE Class 5 level estimate.

#### 3.1.2.3 Groundwater Pumping

CCR units were reviewed to identify the presence of groundwater within the basin resulting from the surrounding conditions. While the presence of groundwater will be addressed to some extent in the dewatering costs within the impoundment during the excavation of the CCR materials (refer to Section 3.1.2.2), the groundwater needs to be controlled/redirected at the CCR unit boundary during closure construction. Where appropriate, costs were included for a groundwater pumping control system to consist of pumping wells installed at 100-foot intervals around the unit perimeter and appropriate system infrastructure to extract groundwater from the wells to reduce potential groundwater underflow during CbR activities. It is assumed that the groundwater pumping system will only be required for one year during closure construction.

#### 3.1.2.4 Water Treatment

*(Same general approach as described in Section 3.1.1.5).* To support closure construction, bulk water (i.e., free water, water collected during dewatering activities, and water extracted via the pore water removal system) present at the CCR unit may need to be treated prior to discharge. For the cost estimate, Duke provided a representative unit cost for water treatment based on actual costs from similar treatment at CCR pond closure sites within the Carolina sites. The unit cost was based on a volume of CCR material treated, which for CbR, was assumed to be the entire volume of CCR within the unit.

#### 3.1.2.5 Excavate and Haul to Landfill

Based on the 2016 volumes present in the CCR units (as provided by Duke), costs were estimated to excavate the CCR materials as well as one additional foot of over-excavation across the unit footprint. The over-excavation is an estimate of additional excavation possible during removal activities in consideration of the potential for migration CCR material into underlying subsoils and comply with the CCR Rule. Consistent with the approach for an AACE Class 5 level estimate, this total volume of CCR and over-excavated subgrade will be hauled to an offsite landfill for disposal.

Offsite landfill locations were assumed by locating municipal solid waste (MSW) landfills within approximately a 30-mile radius of each CCR unit such that at least three alternatives were identified in the search. Based on distance from the CCR unit to the off-site landfills, an average/typical distance was selected and used to determine the haul estimate. A site map illustrating the proximity to off-site landfills has been prepared and included in  Appendix A. For the purpose of this AACE Class 5 level estimate, each landfill was assumed to have sufficient capacity and to be permitted to receive CCR.

#### 3.1.2.6 Tipping Fee

Each offsite landfill assigns a site-specific tipping fee, or a fee paid by a party that is approved to dispose of waste within a landfill in accordance with all applicable regulations. A tipping fee was selected by referencing a representative value for the state based on information contained within the Environmental Research & Education Foundation's (EREF) Analysis of MSW Tipping Fees in 2022. Costs are developed based on the full volume of CCR provided by Duke for each unit, plus the over-excavation calculated in Section 3.1.2.5.

#### 3.1.2.7 Regrade, Seed, and Prepare Site

Once CCR materials are removed, it was assumed the site would be re-graded for proper drainage and revegetated. To this end, each site included costs to remove a portion of the embankments and reuse the soil to assist in the final grading of the unit footprint. To build up this cost, a generalized thickness of three feet of cut and fill grading was assumed. Consistent with an AACE Class 5 level estimate, design of the site contours in the closed configuration was not performed as part of this study.

#### 3.1.2.8 Engineering, Permitting, QA/QC, Owner's Costs and Contingency

*(Similar approach as described in Section 3.1.1.10).* Estimates for engineering, permitting, Quality Assurance/Quality Control (QA/QC), owner's costs and contingency were incorporated based on various percentages of the total costs and/or engineering judgement. QA/QC costs were estimated based on a common per acre rate consistent with the type of services anticipated in the CiP approach. Engineering,

permitting, and owner's costs were estimated as 5% of the subtotal for construction costs and QA/QC (without contingency). Similarly, contingency was estimated as 30% of the subtotal of construction costs and QA/QC, consistent with an AACE Class 5 level estimate.

### 3.1.3 General Assumptions

In addition to the descriptions regarding the approaches for establishing the AACE Class 5 level estimate corresponding to the closure of a CCR unit either by CiP or CbR and the site-specific notes presented in the results (Section 4.0), the following additional key assumptions were made:

- All costs are in 2023 dollars and construction labor is non-union.
- Costs for groundwater treatment and corrective action are not included.
- None of the estimates presented herein include any specific project insurance (such as builder's risk) or taxes for permanently installed equipment and materials.

## 3.2 Unit Rate Development

Critical to the development of an AACE Class 5 level estimate is the establishment of reliable unit rates. To the extent possible, unit rates were based on information from RS Means data from the 2023 Heavy Construction Costs book. Other sources were implemented as necessary to determine costs of specialty items as noted below:

- Vendor pricing was utilized for geosynthetic products such as geomembrane and geocomposite.
- 2022 EREF Analysis of MSW Landfill Tipping Fees was referenced to determine typical tipping fees in North Carolina.
- Pricing from similarly scoped projects was utilized for items such as engineering controls and erosion controls.

## 3.3 Quantity Development

Quantities were developed based on information provided by Duke, publicly available online documents, and engineering judgment. Occasionally, modifications to the estimated quantities were included to account for anticipated construction methods. More specifically, a 10% fill factor was included for all borrow material to account for shrinkage and all geosynthetics quantities for the CiP option include 10% extra material for anchoring, panel overlap, and waste. Quantities were rounded in consideration of the limited accuracy of the estimates developed.

# 4.0 RESULTS

This section presents each of the CCR unit closure costs developed as defined in Table 2-1 based on the descriptions and guiding assumptions established in Section 3.0. Each cost is presented based on a similar set of line items with corresponding site-specific assumptions noted. A complete summary of all of the costs developed as part of this effort is presented in Table 1-1.

## 4.1 Allen

### 4.1.1 Retired Ash Basin

**Table 4-1: Allen Retired Ash Basin CiP Costs**

| Allen Retired Ash Basin - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $772,500 |
| Dewatering | $447,300 |
| Pore Water Removal | $34,799,800 |
| Water Treatment | $6,979,300 |
| Engineering Controls | $135,035,000 |
| Subgrade Preparation | $5,454,700 |
| Cover System | $15,492,100 |
| Stormwater Controls | $1,383,100 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $81,589,000 |
| **Total Project Cost** | **$281,952,800** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of predominately drainage trenches corresponding to a low degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 90% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assumes a targeted ISS system.

### 4.1.2 Active Ash Basin

**Table 4-2: Allen Active Ash Basin CiP Costs**

| Allen Active Ash Basin - Closure in Place | Price |
|---|---:|
| Mobilization/demobilization & site preparation | $1,127,900 |
| Dewatering | $31,338,700 |
| Pore Water Removal | $64,029,800 |
| Water Treatment | $11,795,200 |
| Engineering Controls | $253,070,800 |
| Subgrade Preparation | $9,218,900 |
| Cover System | $25,817,500 |
| Stormwater Controls | $1,672,500 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $161,666,700 |
| **Total Project Cost** | **$559,738,000** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a high degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to the entire pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR Materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

## 4.2 Belews Creek

### 4.2.1 Active Ash Basin

**Table 4-3: Belews Creek Active Ash Basin CiP Costs**

| Belews Creek Active Ash Basin - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $1,715,000 |
| Dewatering | $49,845,400 |
| Pore Water Removal | $95,738,800 |
| Water Treatment | $19,751,500 |
| Engineering Controls | $445,785,200 |
| Subgrade Preparation | $15,437,700 |
| Cover System | $43,146,100 |
| Stormwater Controls | $2,623,300 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $273,698,900 |
| **Total Project Cost** | **$947,741,900** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a high degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 90% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR Materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

## 4.3 Buck

### 4.3.1 Ash Basin 1 & Ash Storage Area

**Table 4-4: Buck Ash Basin 1 & Ash Storage Area CiP Costs**

| Buck Ash Basin 1 + Ash Storage Area - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $721,000 |
| Dewatering | $7,826,100 |
| Pore Water Removal | $31,469,800 |
| Water Treatment | $6,281,400 |
| Engineering Controls | $108,332,200 |
| Subgrade Preparation | $4,909,300 |
| Cover System | $13,885,900 |
| Stormwater Controls | $1,210,700 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $71,154,000 |
| **Total Project Cost** | **$245,790,400** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a moderate degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 90% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

**Table 4-5: Buck Ash Basin 1 & Ash Storage Area CbR Costs**

| Buck Ash Basin 1 + Ash Storage Area - Closure by Removal | Price |
|---|---|
| Mobilization/demobilization & site preparation | $721,000 |
| Dewatering | $26,600,500 |
| Groundwater Pumping | $5,825,800 |
| Water Treatment | $12,800,700 |
| Excavation, loading, and hauling of CCR into on-road trucks | $69,451,400 |
| Tipping fee | $191,842,700 |
| Regrade, seed, and stabilize site | $5,354,800 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $110,662,000 |
| **Total Project Cost** | **$423,258,900** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a moderate degree of saturation.

2. **Hauling of CCR to offsite Landfill**: Based on the evaluation performed for the Buck Plant, a haul distance of 35 miles (one way) was assumed.

### 4.3.2 Ash Basin 2 & 3

**Table 4-6: Buck Ash Basin 2 & 3 CiP Costs**

| Buck Ash Basin 2 - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $1,307,000 |
| Dewatering | $16,773,500 |
| Pore Water Removal | $28,139,800 |
| Water Treatment | $5,583,500 |
| Engineering Controls | $89,986,200 |
| Subgrade Preparation | $4,363,800 |
| Cover System | $12,428,400 |
| Stormwater Controls | $1,284,400 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $65,102,000 |
| **Total Project Cost** | **$224,968,600** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a high degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 90% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

**Table 4-7: Buck Ash Basin 2 & 3 CbR Costs**

| Buck Ash Basin 2 - Closure by Removal | Price |
|---|---|
| Mobilization/demobilization & site preparation | $1,307,000 |
| Dewatering | $50,332,700 |
| Groundwater Pumping | $7,742,300 |
| Water Treatment | $10,317,600 |
| Excavation, loading, and hauling of CCR into on-road trucks | $56,252,100 |
| Tipping fee | $155,370,400 |
| Regrade, seed, and stabilize site | $4,762,200 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $101,243,000 |
| **Total Project Cost** | **$387,327,300** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a high degree of saturation.

2. **Hauling of CCR to offsite Landfill**: Based on the evaluation performed for the Buck Plant, a haul distance of 35 miles (one way) was assumed.

## 4.4 Cliffside

### 4.4.1 Unit 5 Inactive Ash Basin

**Table 4-8: Cliffside Unit 5 Inactive Ash Basin CiP Costs**

| Cliffside Unit 5 Inactive Ash Basin - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $556,200 |
| Dewatering | $316,800 |
| Pore Water Removal | $12,229,800 |
| Water Treatment | $4,048,100 |
| Engineering Controls | $42,459,300 |
| Subgrade Preparation | $3,164,700 |
| Cover System | $9,180,800 |
| Stormwater Controls | $1,282,500 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $30,132,400 |
| **Total Project Cost** | **$103,370,600** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of predominately drainage trenches corresponding to a low degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 50% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

### 4.4.2 Active Ash Basin & Ash Storage 1

**Table 4-9: Cliffside Active Ash Basin & Ash Storage 1 CiP Costs**

| Cliffside Active Ash Basin + Ash Storage 1 - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $896,100 |
| Dewatering | $10,476,600 |
| Pore Water Removal | $38,203,800 |
| Water Treatment | $8,654,600 |
| Engineering Controls | $185,780,100 |
| Subgrade Preparation | $6,764,300 |
| Cover System | $19,108,100 |
| Stormwater Controls | $1,559,200 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $110,365,200 |
| **Total Project Cost** | **$381,808,000** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a moderate degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 80% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

## 4.5 Dan River

### 4.5.1 Primary & Secondary Ash Basin

**Table 4-10: Dan River Primary & Secondary Ash Basin CiP Costs**

| Dan River Primary & Secondary Ash Basin - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $5,271,500 |
| Dewatering | $4,166,400 |
| Pore Water Removal | $17,409,800 |
| Water Treatment | $3,001,200 |
| Engineering Controls | $57,827,000 |
| Subgrade Preparation | $2,346,500 |
| Cover System | $6,686,100 |
| Stormwater Controls | $646,700 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $39,562,900 |
| **Total Project Cost** | **$136,918,100** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Mobilization/demobilization & site preparation**: Based on FEMA flood maps available online, the 100-year flood levels are coincident with the east perimeter of the CCR unit. Therefore, armoring of the exterior slopes was included for the impacted portion of the pond perimeter (approximately 3,450 LF) to 5 ft. above the flood elevation.

2. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a moderate degree of saturation.

3. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to the entire pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

4. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

### 4.5.2 Ash Stack 1

**Table 4-11: Dan River Ash Stack 1 CiP Costs**

| Dan River Ash Stack 1 - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $360,500 |
| Dewatering | $216,500 |
| Pore Water Removal | $3,719,800 |
| Water Treatment | $1,395,900 |
| Engineering Controls | $41,311,000 |
| Subgrade Preparation | $1,091,000 |
| Cover System | $3,135,200 |
| Stormwater Controls | $413,400 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $20,946,000 |
| **Total Project Cost** | **$72,589,300** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of predominately drainage trenches corresponding to a low degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 30% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of

sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

### 4.5.3 Ash Stack 2

**Table 4-12: Dan River Ash Stack 2 CiP Costs**

| Dan River Ash Stack 2 - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $324,500 |
| Dewatering | $198,000 |
| Pore Water Removal | $1,740,300 |
| Water Treatment | $907,400 |
| Engineering Controls | $0 |
| Subgrade Preparation | $710,100 |
| Cover System | $2,194,100 |
| Stormwater Controls | $662,800 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $2,883,900 |
| **Total Project Cost** | **$9,621,100** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Dewatering**: Dewatering to consist of predominately drainage trenches corresponding to a low degree of saturation.

2. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 5% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

3. **Engineering Controls**: Based on the site-specific information available, it does not appear that groundwater is in contact with CCR materials in the basin. Therefore, costs for engineered controls were excluded.

## 4.6 Marshall

### 4.6.1 Active Ash Basin

**Table 4-13: Marshall Active Ash Basin CiP Costs**

| Marshall Active Ash Basin - Closure in Place | Price |
|---|---|
| Mobilization/demobilization & site preparation | $2,193,900 |
| Dewatering | $65,215,000 |
| Pore Water Removal | $126,707,800 |
| Water Treatment | $26,240,500 |
| Engineering Controls | $552,233,700 |
| Subgrade Preparation | $20,509,200 |
| Cover System | $56,907,800 |
| Stormwater Controls | $2,364,600 |
| Engineering, Permitting, QA/QC, Owners Costs, & Contingency | $346,371,800 |
| **Total Project Cost** | **$1,198,744,300** |

AACE Class 5 level cost estimates have been prepared in accordance with the discussions provided in Section 3.0 and supplemented by the site-specific conditions discussed below.

1. **Mobilization/demobilization & site preparation:** Based on FEMA flood maps available online, the 100-year flood levels indicate flooding within the pond footprint and coincident with the pond berm. It is assumed the maps are not currently representative of the site conditions and that a letter of map revision (LOMR) or similar would be prepared and submitted by the Owner to support the pond closure process and ultimately revise the mapping outside of the footprint; therefore, costs for flood mitigation are excluded.

2. **Dewatering**: Dewatering to consist of stockpiling/decanting of CCR material, drainage trenches, geogrid for access roads, and limited amounts of cement stabilization corresponding to a high degree of saturation.

3. **Pore Water Removal**: Assumes well points at a 20-foot spacing installed within the pond limits in areas where separable pore water may be present (corresponding to 90% of the pond footprint) and supported by appropriate extraction infrastructure would be sufficient for removal.

4. **Engineering Controls**: Based on the site-specific information available, groundwater appears to be in contact with CCR materials in the basin and an existing, low permeability soil unit of sufficient thickness is not uniformly present. Therefore, engineered controls assume a targeted ISS system.

# 5.0 QUALIFICATIONS

Burns & McDonnell's estimates, analyses, and recommendations contained in this report are based on professional experience, qualifications, and judgment. Burns & McDonnell has no control over weather; cost and availability of labor, material, and equipment; labor productivity; energy or commodity pricing; demand or usage; population demographics; market conditions; changes in technology; and other economic or political factors affecting such estimates, analyses, and recommendations. Therefore, Burns & McDonnell makes no guarantee or warranty (actual, expressed, or implied) that actual results will not vary, perhaps significantly, from the estimates, analyses, and recommendations contained herein.

In the preparation of this report, the information provided by Duke was used by Burns & McDonnell to make certain assumptions with respect to conditions which may exist in the future. While Burns & McDonnell believes the assumptions made are reasonable for the purposes of this study, Burns & McDonnell makes no representation that the conditions assumed will, in fact, occur. In addition, while Burns & McDonnell has no reason to believe that the information provided by Duke, and on which this report is based, is inaccurate in any material respect, Burns & McDonnell has not independently verified such information and cannot guarantee its accuracy or completeness. To the extent that actual future conditions differ from those assumed herein or from the information provided to Burns & McDonnell, the actual results will vary from those forecasted.

# APPENDIX A - FIGURES


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**PRELIMINARY - NOT FOR CONSTRUCTION**

0 3000' 6000'

SCALE IN FEET

BURNS McDONNELL

date 9/2/2022

designed T. PROPST

**DUKE CCR CLOSURES**

BUCK

LANDFILL LOCATIONS

project 148459

contract -

**B - SK004**

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